



Maximum, Minimum, and Current Temperatures Protocol



Purpose

To measure air temperature at the Atmosphere Study Site

Overview

Climate studies and Earth systems studies require accurate, long-term air temperature measurements.

Time

5 minutes

Level

All

Frequency

Daily within one hour of local solar noon

Key Concepts

Heat
Temperature
Convection
Conduction
Radiation

Skills

Using a thermometer
Recording data
Reading a scale

Materials and Tools

One maximum/minimum thermometer
An instrument shelter
A second thermometer for calibrating the maximum/minimum thermometer
Atmosphere Investigation Data Work Sheet

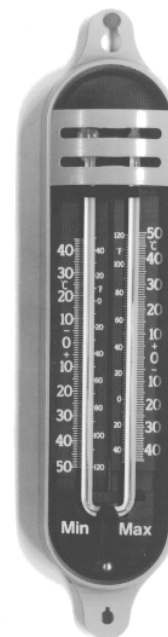
Prerequisites

None

Background

The maximum/minimum thermometer is a U-shaped tube with two indices that indicate the maximum and minimum temperatures. See Figure ATM-P-3. On the maximum side, the temperature scale is such that temperature increases as you go from bottom to top (as with household thermometers). On the minimum side, the scale shows temperature decreasing as you go from bottom to top. Thus, as the temperature increases, the indicator at the top of the mercury column on the maximum side of the thermometer is pushed upward. When the temperature drops, the indicator remains in place to indicate the maximum temperature. Similarly, as the temperature decreases, the indicator above the mercury column on the minimum side is pushed upward. When the temperature again increases, this indicator remains in place to indicate the minimum temperature.

Figure ATM-P-3: Maximum/Minimum Thermometer



Note: The mercury pushes the bottom of indicators until the maximum or minimum temperature is reached. Therefore, students read the maximum and minimum at the bottoms of the indicators.

If your thermometer has a Fahrenheit scale, paint over it so that students will not read it by mistake. Note that the thermometer shown in Figure ATM-P-3 has a Fahrenheit scale which should be painted black.

Before using your maximum/minimum thermometer, make sure that the column of mercury is continuous because it sometimes separates into segments during shipping. If there are gaps in the mercury column, grasp the thermometer by the case, making sure the thermometer is in an upright position, and shake the case until the mercury forms a continuous column. Do not press against the stem of the thermometer as this could cause breakage. You may need to tap the bottom of the thermometer against the palm of your hand as well.

Calibration

Your maximum/minimum thermometer should be calibrated upon installation and again every six months after installation. (More frequent calibration may be required if you find the current temperature does not read the same on both scales or, if at some point, the mercury column becomes discontinuous and needs to be fixed. See above.)

To calibrate the maximum/minimum thermometer, you should compare it with a calibration thermometer. The calibration thermometer will be a typical, liquid-filled, single-tube thermometer that can record temperatures at least as low as -5°C . The calibration thermometer itself must first be tested for accuracy by placing it in an ice-water bath.

1. Prepare a mixture of one part liquid water to one part crushed ice.
2. Allow the ice-water bath to sit for 10 to 15 minutes so it reaches its lowest temperature.
3. The bulb of your calibration thermometer should then be placed in the bath. Gently move the thermometer around in the ice-

water bath so that it will be thoroughly cooled. The thermometer should read between 0.0 and 0.5°C . If it does not, use another thermometer.

4. Once you are confident of the accuracy of your calibration thermometer, hang it by a hook in the instrument shelter. See instructions below for placing the maximum/minimum thermometer.
5. After 24 hours, compare the temperatures on both thermometers. If they differ, the maximum/minimum thermometer should be calibrated to the temperature of the calibration thermometer. Adjust the temperature scales on both sides of the thermometer by loosening the small screw located in the back of the thermometer. Once this screw is loosened, the scales can slide up or down independently of each other.

Placing the Maximum/Minimum Thermometer

Mount the maximum/minimum thermometer in the instrument shelter so that there is air flow all around the thermometer case. The thermometer should be attached to blocks on the rear wall of the shelter so that no part of it touches the walls, floor, or ceiling of the shelter. The thermometer must be 1.5 meters above the ground or 0.6 meters above the average maximum snow depth, whichever is higher. The shelter protects the thermometer from radiation from the sun, sky, ground, and surrounding objects, but allows air to flow through so the air temperature inside the shelter is the same as the air temperature outside the shelter.

The instrument shelter should be mounted on a post that is secured in the ground as firmly as possible so as to eliminate vibrations caused by strong winds. Vibrations can displace the indicators on the maximum/minimum thermometer and thus cause erroneous readings. The shelter's door should face north in the Northern Hemisphere and south in the Southern Hemisphere to reduce exposure of the thermometer to direct sunlight when the door is open for the daily measurement.



The instrument shelter should conform to the specifications given in the *GLOBE Instrument List* in the *Toolkit* section of this guide. It may be constructed using the plan in the Toolkit. It should be painted white both inside and outside. The lock is to prevent tampering with the instruments. Mounting blocks should be installed on the interior to ensure that the maximum/minimum thermometer does not touch the back wall. The door is hinged on the right side (this is not shown in the diagram. The parts should be screwed together. The plans are specified in metric units. See the Toolkit for detailed shelter construction plans.

Once the shelter is in use, occasionally dust its inside with a dry cloth.

How to Measure Air Temperature

1. Assign a team of students to read the thermometer daily within one hour of local solar noon. They should stand as far from the thermometers as possible to prevent body heat from changing the temperature reading. This is very important in cold weather. Do not touch or breathe on the temperature-sensing parts of the thermometer as this, too, may affect the reading.
2. Students should read the current daily temperature at the top of the column of mercury on either the maximum or minimum sides of the u-tube thermometer. Make sure that their eyes are level with the top of the mercury column. Otherwise the reading will be too high or too low.
3. Take the maximum and minimum readings at the base of the indicators. Make sure the eyes of the observer are level with the base of the indicator.
4. Once the maximum, minimum, and current temperatures are read, students should reset the indicators. This is done by using a small magnet to drag the indicators down until they are on top of the mercury column. To avoid losing the magnet, attach it either to the shelter or to the thermometer with a piece of string.

When a temperature observation is missed, reset the thermometer at the next observation and record only the current temperature at that time. Since more than 24 hours have elapsed between readings, we have no way of knowing on which day the maximum and minimum temperatures occurred.

Data Submission

Report the following data to the GLOBE Student Data Server:

- Date and time of the data collection in Universal Time
- Current air temperature
- Maximum daily air temperature
- Minimum daily air temperature